HALF-LIFE & NUCLEAR ENERGY

HALF-LIFE

- Time required for the number of nuclides to reach half the original value

$$t_{1/2} = \frac{\ln(2)}{k} = \frac{0.693}{k}$$

  - k = rate constant
- Example #1:
  - Technetium-99 is used to form pictures of internal organs in the body and is often used to assess heart damage. The rate constant for the decay of $^{99}_{43}Tc$ is known to be 1.16×10^{-1} per hour. What is the half-life of this nuclide?

$$t_{1/2} = \frac{0.693}{0.116\ per\ hour} = 5.98\ hrs$$

HALF-LIFE

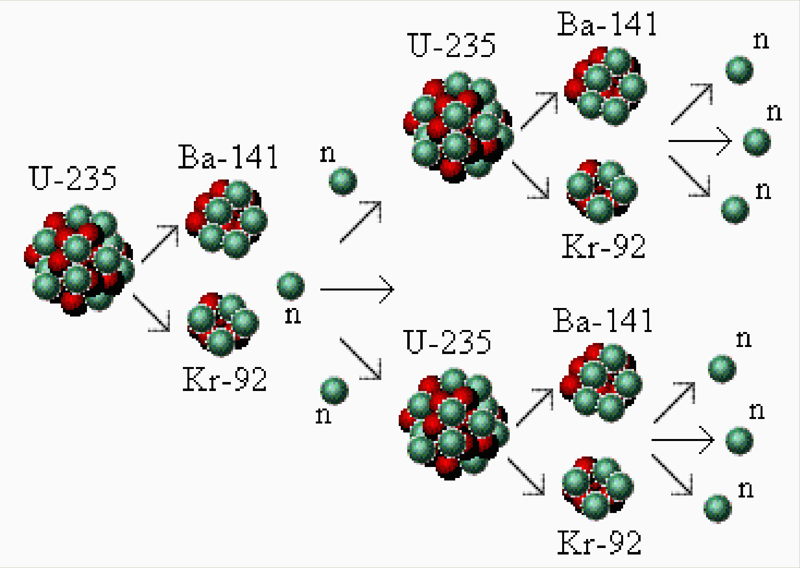
- Example #2:
  - The half-life of molybdenum-99 is 67.0 hrs. How much of a 1.000 mg sample of $^{99}_{42}Mo$ is left after 335 hrs?

NUCLEAR ENERGY

- According to Einstein's equation ($E=mc^2$), less mass equals less energy
  - Nuclear reactions are exothermic
    - Results in less mass
- Nuclear binding energy—the energy required to separate a nucleus into its individual nucleons
  - Larger the binding energy, more stable the atom
- Two types:
  - Fission
  - Fusion

NUCLEAR FISSION

- Splitting of heavy nuclei into two nuclei with smaller mass numbers
  - Requires a neutron to start the reaction
  - Once started, results in a chain reaction
- Critical mass—the amount of fissionable material large enough to maintain the chain reaction with a constant rate of fission
- Uranium-235
- Uses
  - Nuclear power plant
  - Nuclear weapons



NUCLEAR FUSION

- Combining two light nuclei to form a heavier, more stable nucleus
- Occurs only in stars (such as Sun)
  - Appealing as an energy source
  - Too much energy input to make it effective